Four Keys to Circular Recycling

An Aluminum Container Design Guide

The Aluminum Association

Objective

In recent years, the aluminum industry in the United States has noted the increased use of elements including plastic labels and tops, shrink sleeves, adhesives and other non-aluminum components in what have traditionally been single-material aluminum containers. The introduction of these contaminants into the recycling stream is diluting the value of aluminum can recycling, causing operational and compliance problems for recyclers and creating safety issues for workers.

While the aluminum industry recognizes that container design is a dynamic and ever-evolving field, it is important for companies to understand how design choices can impact the recycling of aluminum containers at the end of life. Aluminum container recycling is critical to both the economics and the environmental impact of the product.

In partnership with our member companies – which are responsible for all aluminum can sheet production and the majority of aluminum used beverage can (UBC) recycling in the U.S. – the Aluminum Association has developed this guide to highlight issues and recommend best practices to maximize the economic and environmental benefits of aluminum containers through efficient recycling.

We hope this guide will be helpful to brand owners and packaging engineers in their efforts to design containers that meet consumer needs while maintaining the intrinsic value of aluminum and facilitating its recovery and reuse.

Background on Aluminum Containers

Benefits of Aluminum Containers

Aluminum containers are used extensively because of their unique ability to reliably preserve food and beverages. Aluminum is the lightest material to offer a complete barrier to light, gases and moisture. Further, aluminum containers are efficient to pack and ship, have a uniquely long shelf-life and are readily and economically recyclable at the end of life.

Aluminum containers are available today in a variety of shapes and styles, including cans, bottles and other package types. Most prevalent are two-piece aluminum beverage cans, available in a number of different sizes. These cans contain two distinct alloys – one for the container body and another for the container lid and open-tab. Despite an outwardly simple appearance, the aluminum beverage can is a highly engineered product that has been subject to decades of optimization. Today's cans use nearly 40 percent less material than those produced 50 years ago.[1]

Value of Recycling

Robust recovery and recycling are critical to the sustainable production of aluminum containers.

It saves more than 90 percent of the energy to produce aluminum from recycled material compared to producing new, or primary aluminum.[2] The latest statistics indicate that more than 52 billion aluminum cans are recycled annually in the United States – more than 5 million cans recycled per hour.[3]

In addition, the relative ease of aluminum recycling and the material's high value means that, unlike competing packages made with glass and plastic, used aluminum containers are most often recycled directly back into new aluminum containers. This process occurs repeatedly without significant degradation in aluminum quality. This closed-loop process drives a cycle of relatively high recycling rates and fully 73 percent recycled content in the average aluminum can made in the U.S.[4]

Aluminum can recycling also effectively subsidizes the rest of the U.S. recycling system. A 2020 study by the Recycling Partnership found that, while aluminum packaging represents only about 3 percent of recyclable material generated by a typical single-family home, it represents nearly half of the recycling stream's total economic value.[5]

Aluminum Container Recycling Process

Collection of UBCs

To be recycled, used aluminum containers (UBCs) must first be collected. Either a local government authority arranges a door-to-door collection (often referred to as "curbside" recycling) or consumers return recyclable items to a local recycling center, sometimes under a container deposit system. In addition, recyclables from public and commercial buildings and city streets are often collected by commercial waste management companies.

In many curbside and commercial recycling programs, consumers dispose of recyclable materials into a single bin without any kind of pre-sorting. In this so-called "single stream" recycling system, materials are collected by truck and taken to a Materials Recovery Facility (MRF), where recyclables are sorted partly by hand and partly by machine.[6] The contents of the bins are placed on conveyors to allow for a constant and controlled flow of the material being processed.

Many MRFs use optical sorters which mistakenly sort plastic labeled cans as plastic since the exterior plastic is what is detected by the optic eye, hence contaminating its plastic collection with aluminum, which can mistakenly sort aluminum cans as plastic. If the optic eye reads the exterior label as a plastic container, an aluminum can may be accidentally sorted in with a plastic bale, reducing the amount of valuable aluminum collected by the MRF. Most MRFs also typically use density, size, magnetic and eddy current machinery to separate aluminum containers from other recycled materials such as steel, plastic, paper and glass.

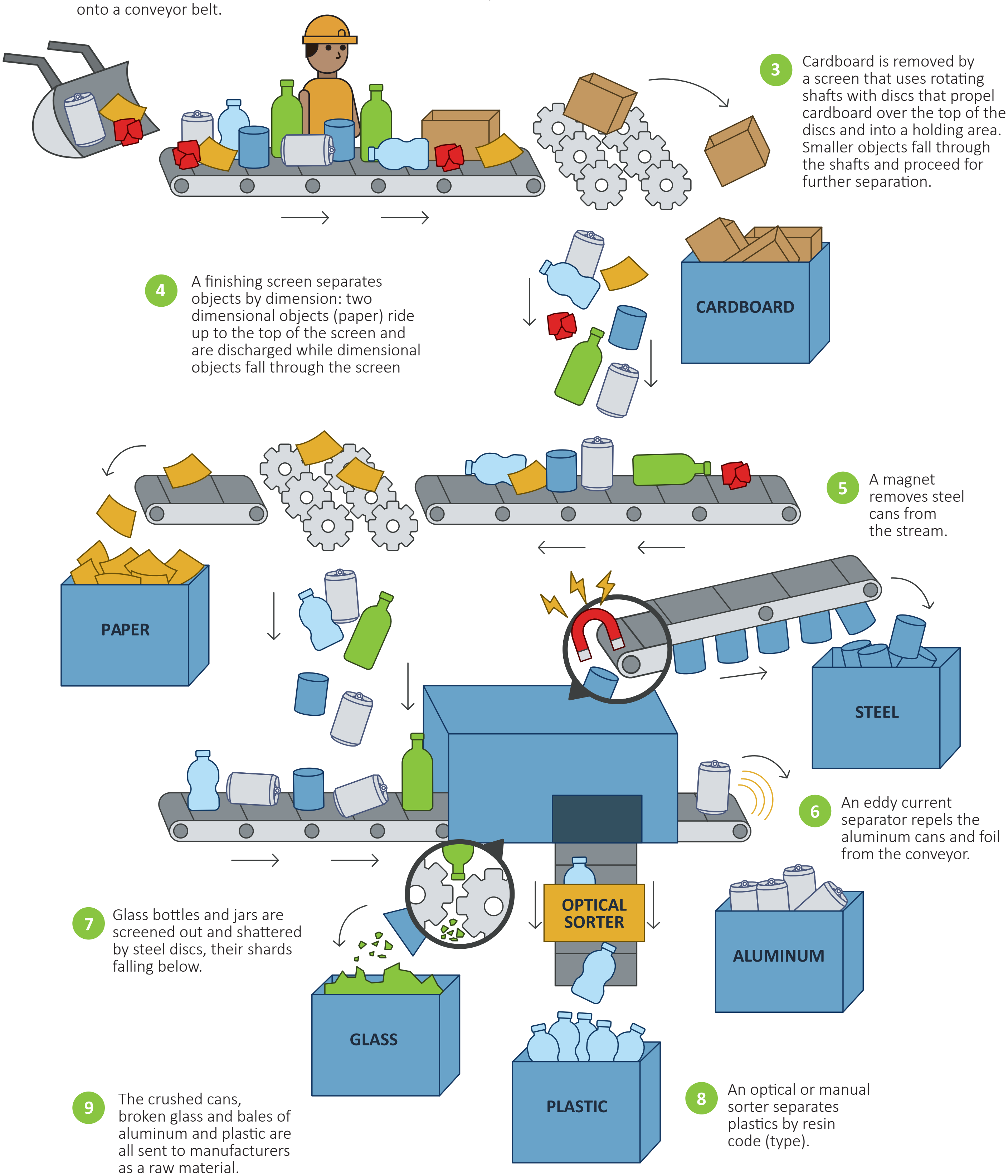
As noted in Capuzzii and Timelli's, "Preparation and Melting of Scrap in Aluminum Recycling: A Review" in Metals 2018:

"Metals with different conductivity produce various eddy currents and will be thrown away at different distances. By setting up collectors at these distances from the rotor, it is possible to separate the scrap stream from the base material. This technique has been increasingly used in the recycling industry since it is possible to recover high-value metals with great selectivity."

An eddy current utilizes a magnetic field to lift and push non-ferrous metals like aluminum to an appropriate collection area while inert materials fall into a different container.[7] Collected (recovered) UBCs are then typically compacted into large blocks (bales) at the MRF for shipment to aluminum recycling facilities where they are used to make new products.

Materials Recovery Facility

1. Trucks unload materials onto the tipping floor at the MRF. A front loader then moves these materials onto a conveyor belt.
2. Sort line workers manually remove film, non-recyclables and bulky items.
3. Cardboard is removed by a screen that uses rotating shafts with discs that propel cardboard over the top of the discs and into a holding area. Smaller objects fall through the shafts and proceed for further separation.
4. A finishing screen separates objects by dimension: two dimensional objects (paper) ride up to the top of the screen and are discharged while dimensional objects fall through the screen
5. A magnet removes steel cans from the stream.
6. An eddy current separator repels the aluminum cans and foil from the conveyor.
7. Glass bottles and jars are screened out and shattered by steel discs, their shards falling below.
8. An optical or manual sorter separates plastics by resin code (type).
9. The crushed cans, broken glass and bales of aluminum and plastic are all sent to manufacturers as a raw material.



Aluminum Container Recycling Process

Processing of Collected UBCs – De-coating and Re-melting

A typical bale of UBCs contains around 94 percent metal content, 5 percent foreign materials and less than 1 percent of other chemical compounds called oxides.[8] However, in recent years, as contamination in the stream has increased, aluminum recycling companies have reported UBC bales with metal content as low as 85 percent.

At recycling facilities, the bales are opened, shredded and run through a high temperature process to remove paints, lacquers and coatings. The aluminum is then sent to a furnace to be melted and purified. It then may have its alloy content adjusted before being cast into an ingot for the next generation of can sheet production. The entire process follows stringent environmental, health and safety controls to ensure the operations meet federal, state and local standards and regulatory requirements.

Challenges in Recycling Aluminum Containers

Even standard two-piece aluminum cans use auxiliary materials like printing inks and coatings that must be removed during recycling. A more recent trend is the wide use of less costly plastic labels or ‘shrink sleeves’ (often by mid-to-small volume craft brewers) wrapped around the can instead of printing a label on the aluminum body surface. Aluminum container designers have also introduced resealable cans and bottles featuring plastic tops and lids. These “composite” beverage and beer cans are made from various plastics such as polyethylene terephthalate (PET) and polyvinyl chloride (PVC). All of these items represent “foreign material” in the aluminum recycling stream that reduces the economic value of the UBC bales being recycled. This material can also create environmental and safety control issues in recycling operations.

Aluminum Container Recycling Process

Increased plastic contamination strains the shredding and de-lacquering systems described previously.

Shredding mechanically reduces the UBC bale into small metal chips and removes most but not all the non-recyclable materials such as plastic tabs, lids, sleeves and labels. De-lacquering removes the rest of the non-recyclable materials such as paints, lacquers and coatings through a thermal process.

During shredding, a portion of the plastics are torn apart and combustible dust accumulates within the shredder enclosure, posing a significant fire and explosion risk. Facilities conducting these processing activities are subject to extensive health and safety requirements under the Occupational Health and Safety Administration (OSHA) regulations.[9] The more plastic that enters this system, the greater the risk. Excessive plastic residue can also gum up shredders, causing equipment downtime. During de-lacquering, plastics can ignite, creating an employee safety issue. Plastic-generated fires and the accumulation of melted plastic can both cause equipment to shut down, increasing downtime for recyclers.

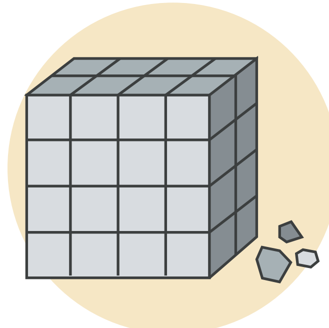
Increased plastic in the recycling stream also poses a variety of environmental challenges. Air emissions from the de-lacquering and subsequent re-melting process are typically fed to a thermal/ catalytic incinerator that converts organic emissions into carbon dioxide (CO2). These emissions are tightly regulated by the Environmental Protection Agency (EPA).[10]

The addition of excessive amounts of PVC (often used in plastic labels and shrink sleeves) into the stream increases chlorine emissions. This exhaust must be incinerated to prevent the emission of chlorine containing dioxins and furans, both of which are classified as hazardous air pollutants.

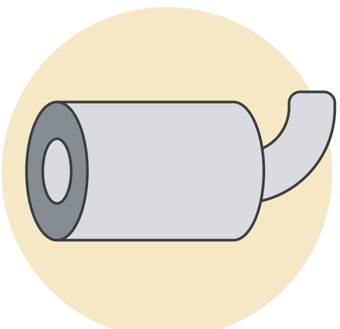
In addition, particulate, hydrochloric acid (HCl) and other emissions may require additional treatment in coated, air filtration baghouses to comply with air quality regulations. Excessive amounts of carbonaceous materials from plastics can also lead to tar-like condensates in these emission control systems and can cause baghouse fires.

Aluminum Can Recycling Flow

1. Collection
UBC collected by volunteers, municipalities, scrap dealers are brought into the recycling center.

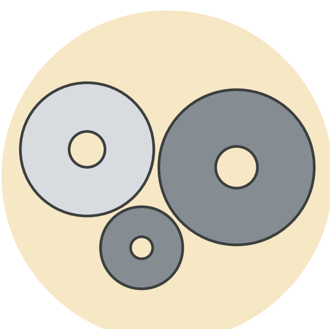


2. Breaking & Separation
UBC compacted into bales are broken up and aluminum cans are magnetically separated from steel cans and other foreign materials.



3. Delacquering
Inks and coating are removed by passing them through the rotary kiln.

4. Remelting & Casting
The aluminum is melted in a melting furnace and cast into slabs.



5. Rolling
Slabs are rolled to produce can stocks.

6. Can Making
Can manufacturers use can stocks to produce new aluminum cans. In the process cans are printed with labels, inner coated and then shipped to beverage manufactuerer's plants for filling.

7. Filling
Bevarage companies fill cans made from recycled UBC.

The Aluminum Association

Keys to Designing Recyclable Aluminum Containers

As companies continue to develop the next generation of innovative designs, the Aluminum Association recommends the following key principles and best practices to ensure that aluminum containers remain 100 percent recyclable.

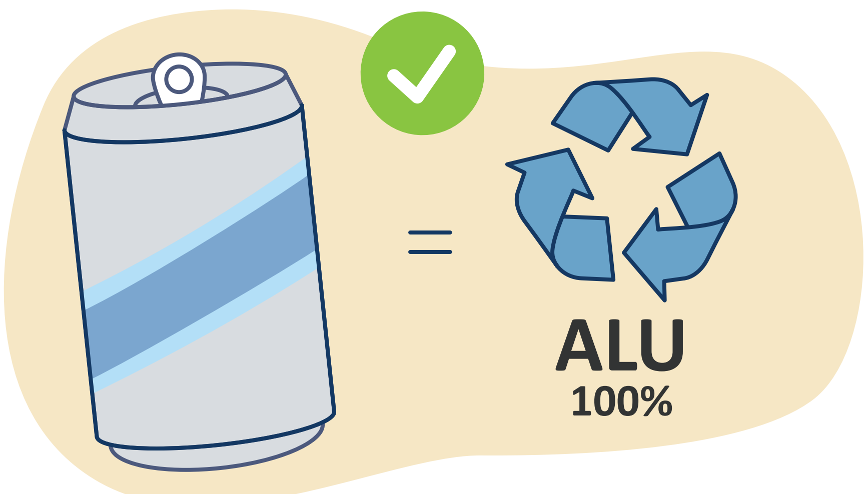
The Aluminum Association

1

Key #1 – Use Aluminum

To maintain and increase the efficiency and economics of recycling, aluminum container designs should maximize the percentage of aluminum and minimize the use of non-aluminum materials.

Each addition of auxiliary material to an aluminum container design should be considered for its effect on recyclability. We encourage aluminum container designers and brand owners to determine whether adding plastic labels, shrink sleeves or lid modifications are necessary and, if possible, consider alternatives. Container designers should understand how contamination can negatively impact today's used aluminum container collection and recycling process infrastructure prior to introducing non-aluminum materials. The use of plastic labels, shrink sleeves and lids may impact the apparent conductivity of aluminum containers and, therefore, reduce the collection rate during eddy current separation. Aluminum cans with PET sleeves could also be incorrectly identified as PET by optical scanners and be lost as PET prior to eddy current separation. As contaminants in the aluminum recycling stream increase, the economic value of recycling decreases, reducing incentives for aluminum container recycling.



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Key #2 – Make Plastic Removable

To the extent that designers use non-aluminum material in their designs, this material should be easily removable and labeled to encourage separation.

A variety of design options exist to encourage consumers to remove auxiliary materials from an aluminum container before recycling. For example, if designers use plastic labels or shrink sleeves, make them easily removeable with instructive labeling that the sleeve should be thrown away and the can recycled. Designers should avoid adding non-aluminum tabs, lids, tops and other items that are not removable.

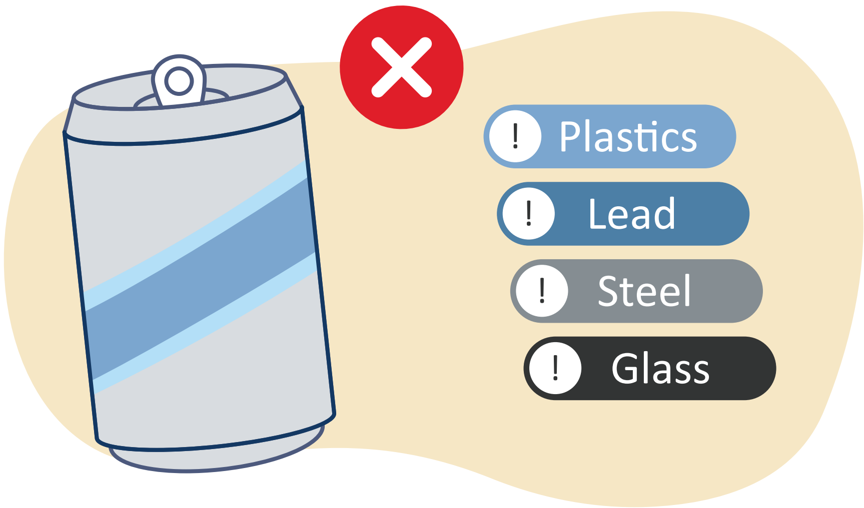
3

Key #3 - Avoid the Addition of Non-Aluminum Design Elements Whenever Possible

Minimize the use of foreign materials in aluminum container design. PVC and chlorine-based plastics, which can create operational, safety and environmental hazards at aluminum recycling facilities, should not be used.

As detailed previously, large amounts of plastic in the aluminum recycling stream can result in excessive dust generation, fires and increased shredder, baghouse and air emission controls downtime. Note that the Institute for Scrap Recycling Industries (ISRI) specification for baled aluminum UBC scrap requires that supplied bales "be magnetically separated material and free of steel, lead, bottle caps, plastic cans and other plastic, glass, wood, dirt, grease, trash and other foreign substances."[11]

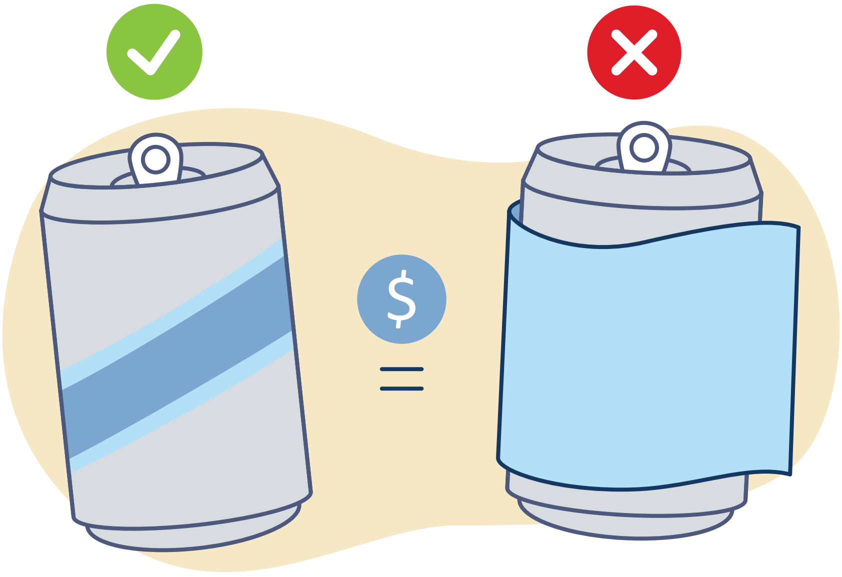
Burning certain types of plastic can increase the emission of hazardous air pollutants in some cases above allowable limits. For this reason, aluminum container designers should not use PVC and other chlorine-based material in plastic shrink sleeves.



Key #4 – Consider Alternative Technologies

Explore design alternatives to avoid adding non-aluminum material to aluminum containers.

In many cases, alternative options exist to meet consumer needs while avoiding the addition of foreign materials to aluminum containers. For example, emerging small scale digital printing technology is now challenging the need to utilize plastic shrink sleeves for local, short run, new and unique products. This technology has advanced to the point of being price competitive with shrink wrapped cans while maintaining the recyclability of the aluminum.



Citations

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